

Proposal

Session Type: Concurrent

Presentation Title: Systems Engineering, Quality and Testing

Presentation Description:

AS9100 has little to say about how to apply a Quality Management System (QMS) to aerospace test programs. There is little in the quality engineering Body of Knowledge that applies to testing, unless it is nondestructive examination or some type of lab or bench testing. If one examines how the systems engineering processes are implemented throughout a test program; and how these processes can be mapped to AS9100, a number of areas for involvement of the quality professional are revealed.

Presentation Summary:

The Systems Engineering (SE) discipline is widely used in aerospace to ensure the progress from Stakeholder Expectations (the President, Congress, the taxpayers) to a successful, delivered product or service. Although this is well known, what is not well known is that these same SE processes are implemented in varying complexity, to prepare for and implement test projects that support research, development, verification & validation, qualification, and acceptance test of major integrated systems or end items..

For this analysis, NASA Procedural Requirements (NPR) 7123.1, *NASA Systems Engineering Processes and Requirements* is used to illustrate the SE processes that are implemented for aerospace testing. Many of these processes are also implemented for smaller test projects, and this set of processes will also look familiar to those who have participated in launch site activation and flight demonstrations.

In studying the Seventeen Processes of the SE "Engine", quality assurance professionals will find many opportunities to apply the lessons from Deming and Crosby for process improvement and defect prevention (e.g. planning, design, continual improvement, supplier and process capability assessments, process control, education and training), and will learn that quality assurance as related to testing is not limited to quality control inspections after the test article is delivered to the test site. There are a multitude of critical processes and stringent design and quality requirements for facilities and support equipment that the quality professional can overlook if the only focus is the test article.

The complexity of the processes will depend upon the life cycle phase (e.g., research vs. qualification), the level of the test article and/or software (e.g., component vs. system), and the type of test (e.g., subscale wind tunnel test vs. integrated stage hot fire).

Processes 1 and 2, Stakeholder Expectation Definition and Technical Requirements Definition, respectively, are mainly performed at the project level (i.e., identification of mission, integrated systems, systems, subsystems, components) before the testing organization is contacted. However, information at this point is often preliminary, and the testing organization may participate in this process in parallel with Technical Planning (Process 10) very early in the life-cycle, especially if new facilities or facility modifications are needed.

The Test Team must go through the logical decomposition process (Process 3) with the customer's Test Requirements Document in order to thoroughly understand the required parameters and derived requirements. They must begin the process of identifying test equipment, test facilities, support equipment, fixtures, software needs, and instrumentation. This is closely followed by design of equipment, fixtures, new facilities or modifications, data channels, and coding of software (Process 4-Design Solution Definition).

The Test Team and the customer must engage in Technical Planning (Process 10) and other Technical Control Processes throughout this activity, such as Risk Management, Configuration Management and Data Management. Depending on the magnitude of the effort, this could be an iterative process that could take many months. Technical requirements, trade studies, cost, schedule, safety, quality assurance, environmental regulations, logistics, calibration, procurements, workforce staffing and training, permits and certifications, codes and standards must be identified, managed, implemented and tracked. Technical Risk Management (Process 13) can be a significant aspect of preparations due to the fact that many customer requirements can change over time and effect test facility design.

The Technical Assessment, i.e. test readiness review (Process 16), is a significant milestone for the testing activity in which a review of the facility design realization process (Processes 5 and 6) and the facility verification and validation processes (7 and 8) have been successfully accomplished.

Some extrapolation is required to apply AS9100 to a testing lab, since testing is a unique combination of building and maintaining infrastructure, and providing a service that requires this infrastructure. However, once the foundation is laid for understanding the implementation of SE processes in a testing environment, the next step is to map the SE processes to AS9100. Once the relationship between AS9100 and SE, and between SE and test organization processes becomes clearer, it can be seen how a QMS can be developed and implemented that serves the testing organization, rather than forcing a product manufacturing paradigm onto a testing service. This understanding is vital, since shortcuts in quality assurance may actually be shortcuts in the SE processes. With an understanding of this relationship, it becomes clear that there is a role for quality assurance in technical planning, process implementation and improvement.

As can be seen, "test" can entail a significant SE effort in the life cycle of a product, which can be underestimated by project managers and overlooked by quality professionals. The application

of AS9100 to test activities should not be limited to acceptance and qualification of the test article, since a Quality Management System can be mapped to SE processes that are implemented during preparations for testing at any point in the life cycle. The aerospace quality professional needs to be able to relate AS9100 to systems engineering and to aerospace testing, so that an approach that goes beyond test article inspection can be formulated to achieve performance excellence and risk reduction.

Division: Aviation, Space and Defense

Focus Area: Practical Application of Quality Tools, Techniques and Methodologies

Presentation Level: Advanced

Industry Area: Aviation/Space

Technical Area: Product or Service Design, Development, Execution

Who Should Attend: Director, Manager, Supervisor, Engineer, Consultant, Auditor, Project Manager

References: I have to various groups regularly since 1980. Most recent presentations were:

- October 13, 2009 Presentation to the Huntsville ASQ Section 1503 “The Role of ASQ in Government Process Improvement Initiatives”
- January 22, 2014 Presentation to the MSFC Quality Management System Steering Committee on “The Proposed Use of Baldrige Performance Excellence Categories at NASA/Marshall Space Flight Center to define Effectiveness Metrics”

Presenter Information: Christena C. Shepherd, Jacobs ESSSA Group; 1500 Perimeter Parkway, Huntsville, AL 35806; 256-544-7419; christena.c.shepherd@nasa.gov; 63141499

Biography: Ms. Shepherd performed quality engineering and quality assurance and functions at the NASA Marshall Space Flight Center from 1980 to 2009, and is currently working for Jacobs Technology in support of the MSFC Engineering Directorate Test Laboratory. She has extensive experience with test programs for NASA, including Space Shuttle, X-33, X-34, Ares, Atlas RD-180, SLS and numerous technology development activities. She has worked on behalf of NASA during the Vandenberg Space Shuttle Launch Site activation, and worked with Stennis Space Center personnel as part of her Test Lab quality assurance support. Ms. Shepherd developed the first ISO 9001 Quality Plan at MSFC and has worked for many years to update and refine the quality management system implementation at MSFC. She currently supports the MSFC Systems Engineering Working Group and the Quality Management System Steering Committee; has a Master of Arts in Organizational Management, and holds the ASQ CMQ/OE and CQA certifications.